

Importation and Establishment of *Lygus* Parasitoids in the San Joaquin Valley and Central Coast of California

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Lygus hesperus (Hemiptera: Miridae) is a pest to numerous seed crops including alfalfa (UC Cooperative Extension 2000). To control this pest in seed alfalfa, four to five applications of insecticides are required each season. It is also a serious pest of several field crops across the United States. In California, it causes about \$30 million in damage to cotton each year. It is also a serious problem to strawberry growers along the central coast of California at an estimated cost of \$40.3 million (www.ipm.ucdavis.edu, Zalom, pers. comm.). Currently *Lygus* is managed on most crops through applications of broad spectrum insecticides. Cultural and biological alternatives are not considered useful. Importation of nymphal parasitoids into the eastern United States during the 1980's, however, successfully reduced *Lygus lineolaris*, a close relative of *L. hesperus* that also infests alfalfa. We have successfully imported and established both *Peristenus stygicus* and *P. digoneutis* in one small plot of alfalfa in Sacramento. Although these parasitoids have been released at two other southern locations in central California, their populations have not increased at these locations as much as they have in Sacramento. Alfalfa cultural practices at our Sacramento release site differ from other locations and may be favoring establishment of these *Lygus* parasitoids. This last year, in addition to making releases of parasitoids, we modified sites to more closely resemble the agronomic practices of alfalfa grown at the Sacramento site.

As in past years, parasitoids were reared at the CDFA's Biological Control Program's headquarters in Sacramento during the spring and summer of 2003. A total of 5,224 adult and 28,070 immature parasitoids were released at five locations over the same time period (Table 1). In addition to releasing parasitoids in central California, releases were made at two central coast locations, one for the first time. These were non-crop sites near strawberry production, a crop that also suffers from *Lygus* damage. Mark Bolda (UC Farm Advisor, Castroville) located the Castroville site, and Ramy Colfer (Mission Organics) helped locate a second site at Harkins Slough near Watsonville.

Parasitism of *Lygus* persisted and increased into 2003, two years after the last releases of *P. stygicus* and *P. digoneutis*. Parasitism reached 75% topping 2002's high of 60% (Figure 1). Maximum number of *Lygus* nymphs over the same years has varied from three to 14 per sweep, and as yet shows no sign of decline. On April 9, 2003, we sampled for *Lygus* in a vacant field 0.3 km from our alfalfa site. *Peristenus stygicus* was found attacking a mix of predominantly *Closterotomus norvegicus* (= *Calocoris*) (Hemiptera: Miridae), and *Lygus* infesting black mustard (*Brassica niger*). Over 60% of these nymphs (n=300) were parasitized. These two findings of increasing parasitism and expansion into outlying fields indicate that these parasitoids are most likely permanently established in the Sacramento region. In contrast, despite additional releases in 2002 and 2003, parasitism has yet to increase significantly at our other central California release sites, including one at the UC Davis (Table 2). On a more positive note, we were surprised by the discovery of parasitoid larvae at our new central coast site. This discovery was made at a control site 300 m from where they were first released six weeks

earlier. Only the introduced parasitoids *Peristenus stygicus* and *P. digoneutis* were recovered, i.e. no native braconids (identification by H. Goulet, Agriculture and Agri-Food Canada).

Table 1. *Peristenus* field release data, 2001 to 2003.

Site	<i>P. stygicus</i> Released		<i>P. digoneutis</i> Released	Nymphs Transferred	Total Insects
	Spain	Italy			
Fresno County					
UC KAC ¹					
2001	0	2,054	1,736	600	4,390
2002	703	0	268	4,603	5,574
2003	1,065	1,201	0	3,316	5,582
Total	1,768	3,255	2,004	8,519	15,546
Kern County					
Poplar Ave					
2001	2,629	0	479	0	3,108
SREC ²					
2001	0	1,732	1,889	0	3,621
2002	674	441	763	3,718	5,596
2003	1,305	967	0	4,982	7,254
Total	1,979	3,140	2,652	8,700	16,471
Madera County					
2001	1,050	0	123	0	1,173
2002	204	0	0	0	204
2003	0	0	0	0	0
Total	1,254	0	123	0	1,377
Merced County					
2001	2,324	0	0	550	2,874
2002	316	0	0	0	316
2003	0	0	0	0	0
Total	2,640	0	0	550	3,190
Monterey County					
Castroville					
2002	0	100	776	1,056	1,932
2003	602	630	295	2,906	4,433
Total	602	730	1,071	3,962	6,365
Sacramento County					
Sacramento					
2001	0	1,520	795	0	2,315
Santa Cruz County					
San Juan Bautista					
2001	1,100	156	53	300	1,609
Harkins Slough					
2003	1,200	1,602	0	4,732	7,535
Yolo County					
UC Davis					
2001	0	0	0	0	0
2002	57	596	1,101	4,450	6,204
2003	1,410	248	2,181	16,866	20,705
Total	1,467	844	3,282	21,316	26,909
Total Released					
2001-2003	14,639	11,247	10,459	48,079	84,424

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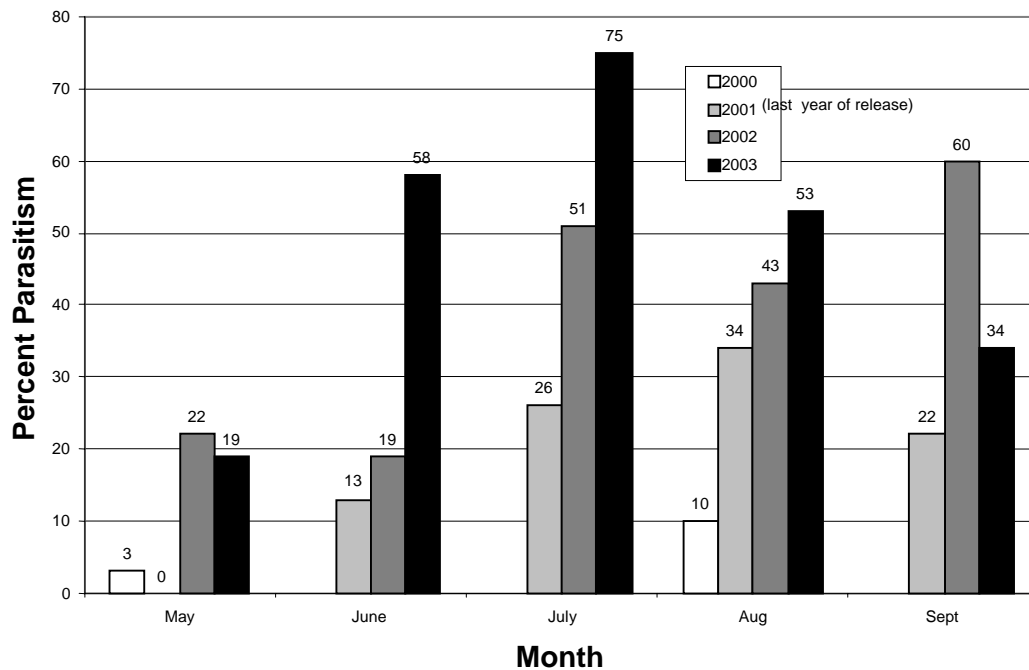


Figure 1. Parasitism of Lygus at the Sacramento site from 2000 to 2003.

Table 2. Recoveries of released parasitoids.

Location	Maximum Percent Parasitism and Sample Size (Number of Hosts Dissected)		
	2001	2002	2003
Sacramento	34.0(32)	60.0(30)	75.0(40)
UC Davis	4.0(50)	2.0(50)	3.5(28)
Merced	14.0(7)	0.0 (0)	
Madera	59.0(2)	0.0(14)	
UC KAC	12.0(25)	10.0(40)	3.3(30)
SREC	5.0(17)	0.0(40)	0.0(45)
Castroville ¹		24.0(25)	7.14(14)
Watsonville (Harkins Slough) ²			2.5(40)

¹ Releases initiated summer 2002.

² Releases initiated summer 2003.

To date, *P. stygicus* has been the dominant species of parasitoid recovered at the Sacramento release site (Table 3). However, the relative proportion of *Peristenus digoneutis* among recovered parasitoids increased to 50% by October 2002. Due to problems with emerging adult wasps, we were unable to replicate the same degree of sampling in 2003.

Table 3. *Peristenus* species recovered at the Sacramento site.

Date sampled	<i>P. stygicus</i> Recovered		<i>P. digoneutis</i> Recovered		Total Parasites Recovered
	No.	Percent	No.	Percent	No.
July 2002	76	95.0	4	5.0	80
August 2002	86	82.7	18	16.3	104
October 2002	5	50.0	5	50.0	10
January 2003 ^A	8	66.6	4	33.4	12
January 2003 ^A	12	85.7	2	14.3	14
July 2003 ^B	16	84.2	3	15.8	19

^A All recoveries were made from soil samples **on two dates**.

^B Two *P. stygicus* and three *P. digoneutis* recovered from soil samples.

Parasitoids are vulnerable to desiccation and predation as they pupate in the soil. The quality of the soil/thatch interface may also affect their survival. Since the beginning of this project in 1998, alfalfa at the Sacramento site was never baled, but was cut and allowed to decompose. In addition, the alfalfa watered with a sprinkler system rather than surface irrigated that could drown late instar parasitoids, and an insectary garden was planted adjacent to this plot. The organic matter resulting from the cut alfalfa has built up over the last five years. The hay was baled at other sites. Beginning in the spring of 2003, the cutting of alfalfa was changed at the UC Davis (20 km west of Sacramento), UC KAC (ca. 300 km south of Sacramento), and the Shafter UC/USDA Research Center (ca. 560 km south of Sacramento) to mimic that done in Sacramento. The UC Davis and Shafter UC/USDA also switched to sprinkler irrigation. Substantial build-up of thatch began by late summer at all locations. We also planted two rows of insectary plants at the UC Davis release site in the spring of 2003 to further mimic the Sacramento release site where *Peristenus* spp. have successfully colonized. These insectary plants consisted of St. Catherine's Lace (*Erigonum giganteum*), *Ammi visnaga*, and golden yarrow (*Achillea* sp.).

In January 2003, soil samples were taken at the Sacramento release site to verify the overwintering location of parasitoid pupae. We used the same technique to develop baseline information on the impact of the above cultural practices on survivorship of parasitoid pupae in the soil at other release sites in July and October 2003. Soil collections came from the upper two to five centimeters of thatch. Fifteen, one square foot samples were taken using a flat shovel across each release site. Each sample was placed into a paper bag and refrigerated at 50°F until further processing. Samples were then placed into paper cans fitted at one end with a glass vial for collection of emerging adult wasps over a two-month period.

Parasitoids have been recovered only from the Sacramento site (Table 4). Nearly one adult *Peristenus* per ft² thatch emerged from a collection made in January, then much fewer in July. No parasitoids were recovered from samples taken at the three other sites.

Table 4. Soil sample recoveries of *Peristenus* species from release sites in 2003.

Date Sampled	Number of Parasites Recovered			
	Sacramento	UC Davis	SREC ¹	UC KAC ²
January	12	0	0	0
July	5	0	0	0
October	0	0	0	0

¹ UC/USDA Shafter Agricultural Research and Experiment Center.

² UC Kearney Agricultural Research Center.

In summary, the results from the last two years of work show that *Peristenus* spp. has most likely become permanently established in the Sacramento region. Recovering *P. stygicus* 300 meters from the original release site in an abandoned field near our release site shows that the population is expanding its range. However, although parasitism has continued to increase since releases ceased, there has been no indication of *Lygus* suppression at this location. Most likely until parasitoids have expanded several kilometers beyond the initial release site, migration of *Lygus* into the isolated alfalfa plot will affect our results. The impact on *Lygus* during a similar effort in eastern United States was not realized until seven years after initial releases. The poor recovery of *Peristenus* from other release sites in central California suggests climate, rather than cultural practices of alfalfa may be limiting its colonization. The rapid recovery of these parasitoids at our central coast sites also indicates a milder climate is important in initial establishment. Other, as yet unidentified native *Lygus* or *Closterotomus* parasitoids found at these sites, but not inland, further suggests that climate is hampering the establishment of the imported *Peristenus*. The continued poor recovery of *Peristenus* at our UC Davis site, only 24 kilometers west of the Sacramento site, on the other hand, suggests that perhaps an unknown factor, other than or in addition to, climate could also be affecting our ability to establish these parasitoids in central California. For example, continuous availability of *Lygus* to the parasitoids during summer months is likely critical to their initial colonization in alfalfa. *Lygus* numbers at the UC Davis have been less than half that at the Sacramento site. During mid-summer at the SREC site in 2003, the *Lygus* nymphal population for unknown reasons dropped to near zero. The release and monitoring of imported *Peristenus* spp. at UC Davis, UC KAC, and the central coast will continue in the summer of 2004.

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